DOCUMENT RESUME

ED 235 029 SE 043 283

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TITLE Weather. Learning in Science Project. Working Paper No. 21.
INSTITUTION Waikato Univ., Hamilton (New Zealand).
PUB DATE Dec 80
NOTE 34p.; For related documents, see ED 226 976 and SE 043 265-315.
AVAILABLE FROM University of Waikato, Science Education Research Unit, Hamilton, New Zealand.
PUB TYPE Reports - Evaluative/Feasibility (142) -- Reports - Research/Technical (143)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Cognitive Processes; Comprehension; *Concept Formation; *Curriculum Development; Elementary School Science; Elementary Secondary Education; Interviews; Learning; Science Education; *Science Instruction; Scientific Concepts; *Secondary School Science; *Weather
IDENTIFIERS *Learning in Science Project; *New Zealand; Science Education Research

ABSTRACT

One area explored in the second (in-depth) phase of the Learning in Science Project was "children's science," defined as views of the world and the meanings for words that children have and bring with them to science lessons. The investigation reported focuses on primary, intermediate, and secondary students' (N=41) ideas about selected aspects of weather. Data were obtained by the "interview-about-instances" procedure in which students were shown diagrams on cards which represent different instances (such as rain) and non-instances (such as moon) of weather phenomena. Selections from interview transcripts are presented, discussed, and analyzed under the following headings: (1) What is weather? (2) What are clouds? (3) What is rain? (4) What makes it rain? (5) What is wind? (6) What starts a wind blowing? (7) What is the difference between fast and slow winds? (8) the moon's part in weather; (9) the sun's part in weather; and (10) Are stars part of our weather? Additional views are presented and discussed as they relate to: self-centered and human viewpoints; animistic viewpoints; non-scientific cause and effect relationships; and weather maps. Several questions for teachers and curriculum developers on childrens' understanding of weather phenomena are outlined. (Supplemental information, including scientific weather facts, is provided in appendices). (JN)

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WEATHER

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WORKING PAPER No. 21

In our view successful science teaching requires an appreciation not only of the scientists' view of the world, but also an appreciation of the language, the beliefs and the expectations which children bring with them to science classes. This working paper has developed from a study carried out in the in-depth phase of the Learning in Science Project and is one of a series of papers which explores aspects of Children's Science (see Working Paper No. 14). It is our hope that these papers portray children's views of the world and meanings for words in a way which will be useful to teachers and to curriculum developers.

In the action-research phase of the project it is our intention to attempt to build practical and useful teaching strategies based on the findings of the in-depth phase of the project. For this reason we are actively seeking comments on the findings we have detailed, and seeking information on the variety of ways teachers develop ideas associated with the topic under focus in this paper.

We would be grateful if comment and/or information could be forwarded to

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WEATHER

A Working Paper of the Learning in Science Project

Ray Moyle

December 1980.

INTRODUCTION

This paper outlines childrens' ideas about aspects of weather. It is one of a series of investigations[1] based on the view that we, as teachers, need to know what understandings and perceptions children have about the world. Here we look at what ideas children hold with regard to weather and what development there is in these ideas as children get older.

In our view it is often difficult for us, as teachers, to investigate children's ideas in normal day-to-day teaching. The multitude of teaching tasks, the range of content areas which has to be covered, the number of pupils in our classes are all factors which lead to a minimum of in-depth dialogue between teacher and learner. Even in the assessment situation often what we see is simply a rewrite by pupils of what has been stated by the teacher but possibly not fully understood by the child.

To teach effectively, we believe, it is necessary for us to really appreciate how children think and present ideas. It is easy to assume that the student's mind is an empty void simply ready to be filled with specific scientific concepts. Such an assumption we believe often generates confusion for the student and creates teaching problems for the teacher. We consider that the learner will often have his own meaning as to how things function built up from his own experiences. What is taught in the formal situation is likely to be interpreted by the student in a unique way and to be placed in memory to be drawn upon at a later point in time.

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1 See also other Working Papers in this series: Living No. 15, Force No. 16, Particles No. 17, Energy No. 18, Friction No. 19, Gravity No. 20, Animals No. 22, Light No. 23, Plants No. 24, Electric Current No. 25.

As Piaget stated in 1929,

> "Even that which seems copied is in reality deformed and recreated. The words the child uses, for example, are the same as we use, but they have a different meaning, either wider or narrower as the case may be. Associations are different: syntax and style original."

It is hoped that this paper gives some insight into what pupils in our classrooms really think about aspects of weather.

THIS STUDY

In the study of children's ideas about weather an individual interview approach was used. In this respect the method of obtaining data was similar to that used in the other working papers in the series[2].

The pupils interviewed consisted of 41 students from five different schools, contributing primary, intermediate and secondary. Teachers were asked to select children in the average to good average ability range. There were 21 boys and 20 girls in the group interviewed, and of this number there were six Polynesian students.

Class	Number	Code
Std. 2	7 Students	01 ... 08
Std. 4	8 Students	001 ... 008
Form 2	9 Students	201 ... 210
Form 4	9 Students	401 ... 409
Form 6	8 Students	601 ... 608[3]

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2 The rationale behind the approach is referred in Working Paper No. 14; Reconsidering the Framework.

3 Of the Form 6 students, two were studying Physics and/or Chemistry. All the remainder had taken Science and Biology in the fifth form.

The first number denotes the class level, while the last number gives the interviewer sequence. Male students are identified by the last digit being an even number, the female students denoted by odd numbers.

In the interview situation each student was shown a card with a picture showing an aspect of weather (see Appendix 1). Seven cards made up the set. Numbers 1-6 showed aspects and non-aspects of weather, i.e. clouds, rain, wind, sun, moon and stars. The seventh card was a weather map drawn from the N.Z. Herald.

The interviews had a structure in that they followed a set sequence in the use of the cards, and for each card key questions to focus discussion were asked (see Appendix 2). Further questions were asked to investigate additional ideas held by the pupils. These questions took up and explored particular statements made, and depended on the responses and vocabulary used by the students. At the start of the interview the purpose of the interview was outlined and the pupils were asked to express in general terms what they meant by "weather".

SPECIFIC VIEWS RELATED TO ASPECTS OF WEATHER

A representative sample of the responses to the main questions posed are given in the following section. Similar responses are indicated by the identification numbers of the pupils at the end of each selected statement.

(a) What is weather?

Responses to this tended to be restricted to the sun, rain, wind and 'bad weather'. Nine students gave no response or were very vague in stating a clear definition of weather. Some of the other responses were:

"Clouds and rain and things that fill the sky."
(01, 02, 006, 405, 407, 602)

"Some weather is bad and some weather is good, it comes down to earth and it can be sunny or rainy."
(06, 05, 002, 004, 404, 409, 605)

"It's what happens when it's really sunny ... it's sunny or it rains."
(08, 003, 202, 210)

"Well, it's the climate, it's different times of the year."
(205, 406)

"It's when the sun shines and it rains and it's different temperatures."
(207, 408, 608)

"It's rain, sun and atmosphere."
(005, 204, 401, 402, 403, 601, 606)

"Sunshine and rain ... it's just a cycle of rain."
(604)

"Temperature, how cold the day will be."
(001)

"It affects people." (206)

(b) What are clouds? (card 1)

"It's water that evaporates from the ground."
(01, 602, 606)

"Evaporated water." (002, 201, 207, 204, 601)

"Kinda like cotton wool, clouds are just tiny bits of mist, all together and fluffy." (02)

"Little cotton wool things in the sky, but I think they have something to do with the blue and white sky together. They are connected but I don't know how."
(401)

"Air in the sky and some chemicals."
(402, 406)

"Sort of formation of gases, or smoke."
(03, 008, 206, 603, 605, 607)

"Moisture in the air." (004, 202, 208, 210, 404, 409)

(c) What is rain? (card 2)

"Water from the clouds." (03, 004, 006, 201, 205, 206, 208, 210, 204, 606, 607)

"It's stuff that comes out on rainy days."
(05)

"It's water vapour all gathered up in the clouds."
(002, 203, 405)

"Water that condenses by temperature inside the clouds. Clouds have got too full of this water, like if you are holding water in cotton wool, it just starts to drip out." (407)

"All the moisture is stored up in the chemicals and when there is a severe wind it causes a break in the chemical links or chains that forms the clouds and the rain falls down." (406)

Very few students referred to the cyclic effect that goes on in making rain. Only four of the older students made any reference to a recycling of water. Their comments about rain were:

"It's what the sun evaporates and makes it go up into the clouds and when it gets cold it just rains ... it keeps going round and round in circles." (403)

"It's just from other rain when it gets down with a lot of other water it goes up again. Gets evaporated up again . . it is sort of like a cycle." (408, 604)

"It's water like particles ... excess that falls onto the ground, has been soaked up into the clouds and once the clouds have become too heavy they drop the rain ... sort of recycling." (607)

Perhaps it could be pointed out that one of the understandings hoped to be developed in the Syllabus at the level three stage (8 years - 11 years) on Matter, is that 'water is recirculated naturally - water cycle' (p. 66 content areas - Primary Syllabus).

(d) What makes it rain? (card 2)

While four students, three Std 2 and one Form 2, had no clear view on this question the remainder of the students saw clouds as holding only a certain amount of water and breaking open or 'bursting' in a way a paper bag or balloon might fracture.

"The clouds get so full they burst and the rain comes down." (01, 06, 004, 006, 203, 206, 402, 404)

"Some of the clouds just disintegrate. The clouds are just made up of raindrops and the drops come down. The clouds go all black when it rains." (003, 005, 002, 007, 008, 203, 210, 401, 403)

"When they get full of water they just sort of explode and it begins to rain ... the water gets too heavy that it just sort of floods." (207)

"Clouds are full of water and they just let it out again. I don't know how they do it ... they just get too heavy and they let it out again." (606)

"Just clouds getting filled up with rain and they can't hold any more." (204, 601, 604, 608)

Others had similar, if slightly less specific views, for example:

"It just builds up and comes out." (202, 208, 405, 602, 604, 605)

"It gets too dense... the level of density gets too much and it just falls." (608)

Five students saw that a collision between clouds could cause a breaking of the clouds and the subsequent downfall of rain.

"The clouds crunch up together and it rains." (02, 001)

"Something is pushing it to make it come out." (007)

"Being pushed and shoved around makes them break." (Std 4 Girl Prelim.[3])

"The wind blows it out." (202)

"When clouds pass one and other it starts raining when they hit." (408)

"They pass over and they go black, and then they crash together and make thunder and rain." (F.2 Boy. F.2. Girl Prelim.)

(e) What is wind? (card 3)

Wind is seen by 19 students as masses of moving air. They accept that it is there and have various ideas as to its creation. Only the older students, 1 x S4, 3 x F4 and 3 x F6, were able to relate wind to other aspects of weather. They could see a relationship between heat or rising areas of air but the differences of pressure areas were not clearly expressed. Twelve students were not sure or were unable to offer any explanation about wind. Other responses included:

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3. A few quotations from preliminary interviews of students are included where they are particularly pertinent.

"Wind is most probably from the clouds ... the water in the clouds helps to blow and makes the wind."
(01, 02, 001)

"It's air rushing or going fast." (03, 08, 001, 002, 004)

"Oh! it is air being pushed; it's formed through currents in the air, clouds make the wind; if you look at clouds you see that they are all swirly and it is usually a windy day."
(409)

"It is from the air that is heated; when it rises other air rushes to fill in the gaps." (408)

"Something or a force that blows."
(007, 202, 003, 404)

"Wind comes in storms." (06)

"A gas moving fast." (204)

(f) What starts a wind going? (card 3)

In response to this question, sixteen of the students stated "I don't know, I am not sure," and gave no response.

While no pupil gave a good scientific explanation, about one-third of the pupils gave answers vaguely related to aspects of the scientific viewpoint.

"Oh, it is just heated air rising."
(408, 203)

"Force of air and gases as the earth moves."
(206,602)

"Movement of the earth." (206, 602, 605)

"Winds start from the N. or S. Poles as there is coldness there and sometimes the wind blows and this makes the wind."
(04, 06, 403, 405)

"From the air when the rain comes down."
(08)

Others responded with more novel cause - and - effect answers

"The clouds moving." (004, 005, 007, F2 boy Prelim)

"The tides start the winds going."
(402, 605)

"From the trees when they blow." (001)

Two pupils responded in terms of much more local effects

"Can be trucks as they go along, the speed makes the air come out from behind them ... sometimes it is from planes and rockets." (006)

"Like people running and aeroplanes causing big winds." (210)

(g) What is the difference between a fast wind and a slow wind?

Once again some fourteen students interviewed did not know or were unable to give an explanation to the question asked. The remainder of the responses show a wide range of cause and effect relationship, and are closely related to the ideas students interviewed have to previous questions asked. Only three responses have any reference to the effects of pressure.

(i) Pressure

"A great amount of air pressure."(401)

"It's a difference of pressure of some sort." (403, 404)

(ii) Difference due to temperature variation

"A fast wind is colder than a soft wind. A soft wind is warm." (06, 206, 405, 001)

"A gentle breeze on a sort of a hot day, then it is like what you get in the tropics ... you get hurricanes because it is much hotter there." (408)

(iii) Influence of clouds

"Clouds blocking a wind makes a slow wind, high mountains also help make a slow wind." (402, 602)

"Clouds with water make a fast wind and slow winds are clouds with not so much water to push it." (004, 005, 602)

"The seas and storms make a great wind ... when the waves go crashing it causes a current of air ... fast winds are a great pressure of water on the air.". (003)

(iv) Difference due to objects about us

"A slow wind not travelling so fast, like from a car not going fast, and a fast wind could be from a truck going fast and it is wide." (006)

"A fast wind is caused by lots of things ... like birds flying." (210)

(v) Winds combining

"Well if a light wind is blowing one way ... and another wind is blowing the same way ... if the other wind catches up to the other wind .... um ... it goes in there and joins on and it goes faster as it has twice the power." (207, 02)

(vi) Land relief

"I suppose the relief of the land makes all the difference." (01, 402, 601, 605)

(vii) Winds created by rain

"Fast winds are tornados and storms, rain makes these." (604, 606, 608)

The distinct impression gained is that for some 25% of children at least the wind is caused by some other moving object e.g. clouds, cars, rain and so on. Experience of wind from moving cars, trucks etc and their inability to detect with the senses air pressure differences and to observe the creation of different pressures of air by temperature and so on, leads us to the realisation that a child could well look for causes of wind only in terms of visible moving objects.

(h) The moon's part in weather

T e moo , was used as a distractor in the investigations, but it did provide indications that a number of students saw it as a factor in weather. Twenty-six students did not see the moon as influencing weather. On the other hand this means a significant group did see the moon as influencing weather in some way.

(i) Moon affecting tides and thus creating winds

"The moon makes the tides go in and out and the tides make the wind." (003, 006, 203, 404, 405, 407)

"Yes the tides, which move water from place to place ... rather like a tidal wave causing more moisture in the air." (406)

"Something to do with the tides ... the tides and the winds are connected." (605, 607)

(ii) Size of the moon

"Well I think when the moon is big in the daytime its not going to be so dark at night. When it is the daytime its going to be dark at night." (02)

"When the moon is out you can see better at night." (602)

(iii) Moon creating rain

"Oh, it is the thing that makes the rain, sometimes when the moon is up the rain comes down." (08)

(iv) Effect on night weather

"It has to do with weather at night." (005, 401)

The above quotations show interesting views on the position of the moon in the sky during a 24 hour period and suggest some students consider the brightness of the moon at night is an aspect of weather.

(i) The sun's part in weather

All students saw the sun as being important in weather and most saw it providing heat and/or light to the earth. The sun was seen as vital in surviving and essential to life.

(i) The sun and cloud formation

"The sun evaporates the water which goes up to the clouds and the sun gives down heat." (004, 006, 008, 203, 204, 403, 404, 406, 408, 409, 604, 607, 608)

(ii) The sun in the water cycle

"Yes it is the main part in weather because it evaporates water from the seas and lakes ... it goes through a cycle and if it wasn't for the sun we wouldn't have rain."
(008)

(iii) The sun causing wind

"It heats the air and this causes winds."
(408, 605)

(iv) Importance due to size

"It is the main source of weather, just looking at it, it has size first, it's there and it provides light."
(407)

(v) Heat and light

"It lights up the world and makes it hot/fine."
(01, 02, 03, 04, 05, 08, 001, 002, 005, 006, 007, 201, 206, 205, 401, 402, 602)

(vi) Importance in a biological sense

"Provides us with energy and heat and keeps things alive."
(405)

"It makes plants grow." (601, 607)

"Actually we need the sun; if we didn't have the sun we would not be able to live."(603)

"The sun makes the sky, sometimes it makes the rain."
(003)

(j) Are stars part of our weather?

In response to this question the majority of the students saw that the stars had no part in our weather, or they didn't know of any influence. Five students did see them as having a part due to their similarities to other objects that have an influence on weather.

(i) Relationship to the sun

"Yes the stars do have an influence because they are suns like the sun we have and they give light."
(208)

(ii) Relationship to the moon

"Stars cause weather at night because they are smaller versions of the moon." (401, 601)

(iii) Indicators of weather

"When it is fine there are lots of stars at night, when it it raining there is hardly any." (207)

(iv) Falling stars

"Only if they crash onto earth and they cause volcanoes to erupt or make earthquakes." (210)

As a supplement to the investigation of pupils' views on the influence of the moon, stars and sun on the weather, children were asked about their views on the relative distances from earth to the sun, the moon and the stars. This additional study is detailed in Appendix 4.

FURTHER ASPECTS OF STUDENTS' VIEWS

In this section, additional views held by students about weather are described.

(a) Self centred and human centred viewpoints

(i) Usefulness

"It's water, and it's good to have because people might run out of water." (rain 08)

"If we didn't have the sun we couldn't see where we are going." (01, 08)

"The sun warms us up like hot water. When it is sunny and warm the temperature is in degrees." (04)

"The sun is good for hopping into pools if you are not." (08)

"The sun comes out on a fine day and makes it a good day." (002, 007, 404, 602)

"Wind is something that dries up clothes." (04, 005, 201)

(ii) Usefulness in a biological sense

"It is important quite a lot; the sun provides us with a lot of energy and heat and keeps things alive."
(405)

"It makes things warmer and makes plants grow."
(sun 601)

"Actually we need the sun; if we didn't have the sun we would not be able to live." (603)

(iii) Bad effects

"It makes the desert dry and the weather warm. Old people don't like it and get out their sun umbrellas."
(06)

"The sun's rays are really hot, it could start fires, it makes the air really stuffy. Where there is a lot of heat it could affect you. We would have wet weather if we didn't have the sun." (210)

"Makes droughts when there is no rain; when it hasn't been raining for a while the rivers dry up."
(606)

"Stuff that blows trees over." (wind, 606)

"A fast wind will take things along with it."
(007)

"Well the clouds get too big with rain drops inside and they burst and go into rain and not many people like rain."
(06)

(vi) Influence of God in weather formation

"It's what people think about really, strange things can happen, it's got something to do with God up in heaven, he does some strange things sometimes ... sometimes we can get really bad weather and no one knows what the cause of it is. I don't think in years to come man is going to find out how it comes. it might be God up in heaven being angry with us ....."
(response to the question, What is weather?, 401)

"It just seems to come out all of a sudden .... I don't know why ... but I have always thought that God has got a lot to do with weather. Its just something I believe in, it has got to be SOMEONE that brings weather on and I think that is just the way it comes."

(response to the question on the difference betweeen a fast wind and a slow wind, 401)

(b) Attributing Human or Animal Characteristics to Inanimate Objects.

(i) Clouds

"They can go anywhere they like, but actually they just go around the world." (S.2. Girl. Prelim.)

(ii) Sun

"It comes up, it wakes up." (S.4. Girls. Prelim.)

(iii) Moon

"The moon has to go to other places in the world." (S.4. Boy. Prelim.)

(iv) Rain

"It just feels like it ... it is time to get out anyway ... it sort of depends on the weather." (407)

(c) Children's views expressing non-scientific cause and effect relationships.

Some interesting and novel views expressing non-scientific cause and effect relationships were provided by children.

"I think the rain comes from the moon 'cos the moon is a cold place. The sun hasn't got any water 'cos it is a hot place. The moon is up there and it come out of the moon, (rain) it comes into the clouds and it goes down into the earth." (08)

"Winds come from the openings in the clouds, the air is just pushing through the gaps ... you can tell because the edges of the clouds are all swirly." (409)

"The moon is connected with earthquakes and volcanoes erupting." (04)

"Wind is like when you blow out ... there is gravity out there and the air you have pushes it out and it sort of floats (wind)." (04)

"When trees blow they make a gust of air and the trees blow it and it comes to the clouds ... when it is a cold day it will blow faster because the trees bend over more and make the rush come faster. A slow wind comes when the trees don't bend over so much and the day is not so cold." (001)

> "The stars sort of influence the weather. When it is fine there are lots of them, and when it is raining there is hardly any of them; they make things hotter because they are sort of balls of fire, so that it's going to be a fine day when they are out."
>
> (207)

Cause and effect relationships are interesting with respect to weather. The problems are that apparent prime causes, e.g. the sun, do not always lead to the same effects, such as the complexity of weather. Secondly, and in our view more importantly, when it comes to children's understandings the secondary causes of winds in particular and to some extent clouds and rain, are things such as air temperature and pressure differences. Such concepts are abstract and not detectable by the senses. Children tend to look for causes in terms of concrete objects which can be detected by the senses.

WEATHER MAPS

As part of this study it was decided to investigate children's perceptions of weather maps. Weather maps are specifically mentioned in the Draft F1 to 4 Science Syllabus (p.27) where it is hoped students will develop the ability to:

> "relate measurements to data published by newspapers, radio and television, and to weather maps provided by the metereological service."

To gauge some appreciation of children's understanding about weather maps, three questions were directed to the students in reading and interpreting a weather map. The response to these questions produced a whole range of ideas and thinking. The questions were:

1. What are those H's for?
2. What is the L for?
3. What do all those lines mean? [isobars - Appendix 3 Map].

(b) What are the H's for?

Six students were not able to give any clear statement to describe the H's. The other explanations were,

(i) H is for Hot

"H's show where it is going to be hot ... it's where the sun is shining ... it's fine." (02, 06, 002, 008, 201, 203, 204, 206, 207, 402, 403, 405, 408, 409, 601, 602, 608)

"It is hot air from Australia." (402)

"Warm air." (406)

"H's could be heat and height." (210)

"Probably warm weather because they are near the equator." (405)

"Hot weather, that and heat coming from the equator." (601)

"Sometimes it is the sun on the equator, sometimes they meet and they make a hot patch and it is like a clump of mountains." (02)

(ii) H is for high winds

"H's are the heavy ones, they are strong winds like the roaring forties." (002)

"H's are for head winds, forces pushing the winds along." (005, 006, 404)

(iii) H is for high pressure

Only four students related the H's to their correct scientific meaning.

"H's are high pressure areas made by the weather currents where the wind is from." (404, 604, 605, 601)

(iv) H is for "anything you can think of beginning with H".

"H's are weather going to Hamilton." (03)

"Oh, they are something to with the horizon." (205)

"The two H's are for cities and countries." (05)

"The horizon" (201)

(c) What are the L's for?

The L's on the map tended to be associated with bad weather conditions. Twelve of the students were unable to offer any explanation as to what a low was or stated that a low was a 'low'.

(i) L is for bad weather

"Means cold and wet or rainy." (02, 04, 05, 202, 201, 206, 402, 403, 406, 407, 408, 409, 608)

"Cold air." (406)

"Where the clouds are." (204)

"L's thats bad weather coming because it is colder down here in the South Pole." (405, 602, 603)

(ii) L is for low temperature

"L's are for low temperature because it is further away from the equator." (008)

"Low temperature." (607)

(iii) L is something to do with the wind

"Wind or something." (004, 005)

"L.s are for left winds." (006)

"Winds or something." (08)

"Low winds." (005)

(iv) L is for low pressure

Those students who associated H with high pressure also associated low with low pressure. Only one student interviewed related areas of high pressure with areas of low pressure. On all other interviews no one offered as an explanation any connection between the two.

"If you have high pressure somewhere you have to have low pressure somewhere else." (601)

(d) Student's interpretations of isobar lines

Over one third, 15 students, were unable to offer any idea as to what the lines indicate on weather maps. Those who did offer ideas were varied and inaccurate.

(i) Indicators of wind

"The lines are different parts of the wind."
(006, 008, 408)

"Lines show the weather crossing and the winds."
(004, 205)

"Lines show where it's windy, when they are closer together, and less windy when they are further apart."
(601)

"Lines are winds or air streams."
(409, 407, 606)

"Lines are winds changing direction."
(603)

"Lines tell how fast the wind is going."
(607)

(ii) Indicators of temperature

"The lines are heat barriers when it starts being hot or cold."
(202)

"The lines are heat lines." (008, 204, 403, 206, 405)

"Where the temperature is passing over."
(207, 408)

"The lines are heat moving out till it is cooled by the low pressure area." (210, 602, 604)

(iii) Indicators of weather

"The lines show where the weather is coming from."
(005, 405)

"Tells what the weather might be."
(001)

"Joins parts where the weather is the same."
(605)

"Density or something." (608)

A weather map is presented daily on T.V. and also in daily newspapers, this giving a regular illustration of daily weather patterns. Most of the students interviewed, despite this continual experience of weather maps, have concepts in this area that do not show an accurate or full understanding of the information given in the official weather reports. One would assume that many adults have similar conceptions. Lindsay Perigo, in discussion with Helen Pask, reported in

the Listener, 18 October 1980, had this to say of his career before he became a hard-hitting, but well-informed radio interviewer. He read the news, which he liked, and the weather which he hated "I didn't even know what a depression was." It is interesting that by way of contrast he thoroughly researched the material he used in his current affairs interviews. Is his attitude to the weather typical of that of many adults?

SUMMARY

The students interviewed varied considerably in age and educational experiences, but in no age group were sound scientific concepts held on all aspects of weather phenomena.

Given the views that students hold it seems to us that this raises questions about the appropriateness of the aims of the Primary and Form 1-4 Syllabuses with regard to the topic of weather.[4].

Undoubtedly weather is a complex natural phenomena which is difficult to understand and predict. How much do children need to know about the basic mechanisms of weather, e.g. the water cycle? If, as the syllabuses suggest, children measure and record air pressure differences should children have some appreciation of how air pressure differences influence aspects of the weather? Should they understand what the symbols on a weather map mean and how the concepts represented by the symbols can, and do, influence the weather? Do we need to explain why the moon and the stars have no real influence on the weather?

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4. For example, the new Science Syllabus, Primary to S.4, sets out understandings and skills that teachers need to cultivate in this area. To highlight just two aspects, it is expected that children will develop an understanding as to the part that water has in our world, and how it exists in its three states. There has to be some understanding developed as to how air acts under various conditions. To aid these understandings some experience is needed in taking instrument readings of air pressure (pg. 66-67. Content Area .. Syllabus 1980). With respect to the Form 1-4 Draft Syllabus, brief reference is made to weather as detailed previously in this paper and attempts to relate earlier understandings to ideas of reading weather maps and predicting the weather.

5. Working Paper No. 26 Physical Change also provides information which may be useful in the consideration of this question.

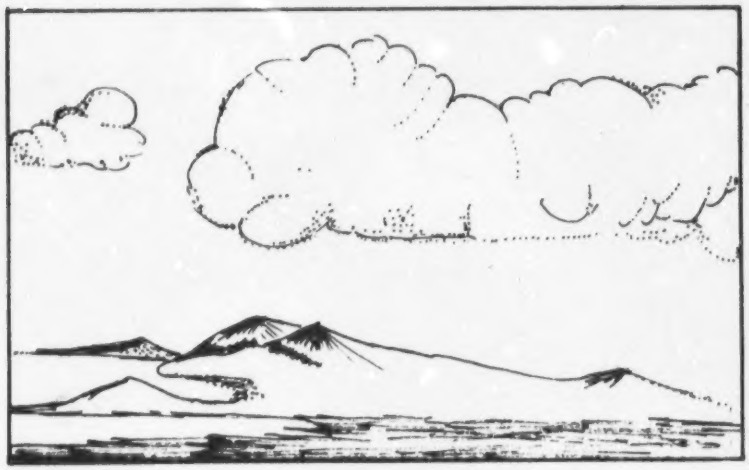
Because so much of what children learn about weather occurs outside school through experience, looking at the T.V. weather map, and talking to members of the family group and friends, it is important in our view that the development of a more scientific perspective on weather builds upon the children's present knowledge.

As with many of our studies we are not sure if we, as teachers or curriculum developers, have in the past made correct assumptions about what children know and understand about weather. Hopefully this paper will lead to a re-analysis of our assumptions.

ACKNOWLEDGEMENTS

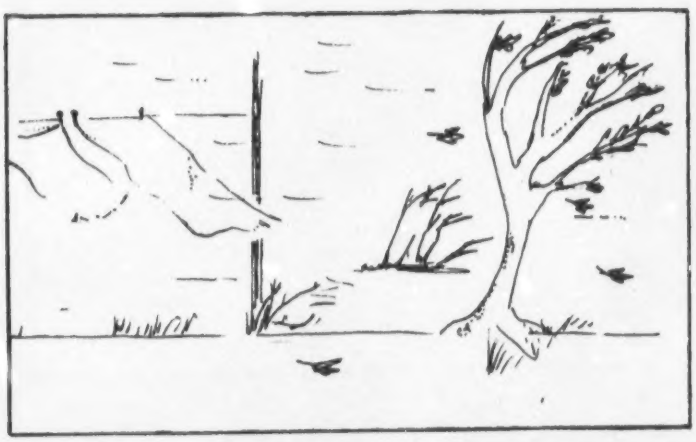
I would like to thank Peter Freyberg, Roger Osborne and John Happs. All these people have contributed valuable discussion in the preparation of the paper.

Appendix 1: Line drawings depicting the photographs used to gather ideas students held about weather.



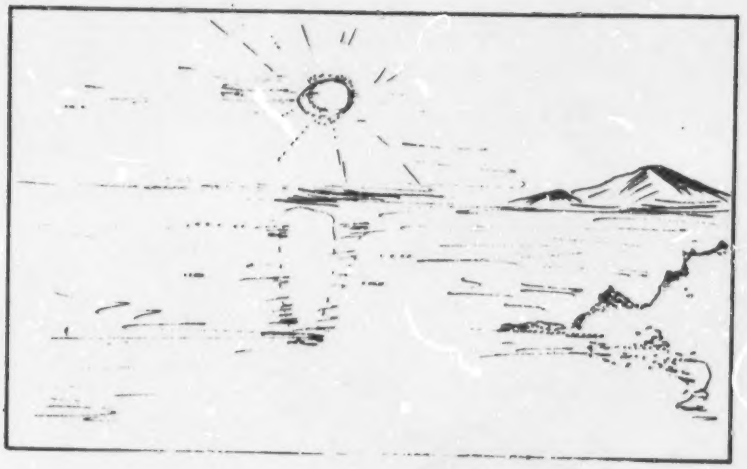
CARD 1

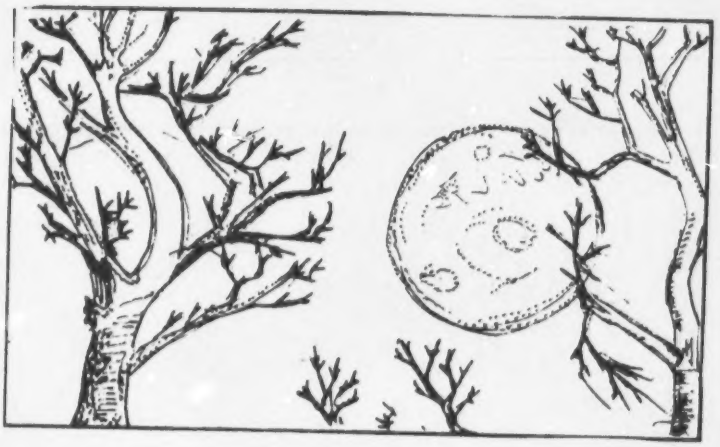
CARD 2



CARD 3

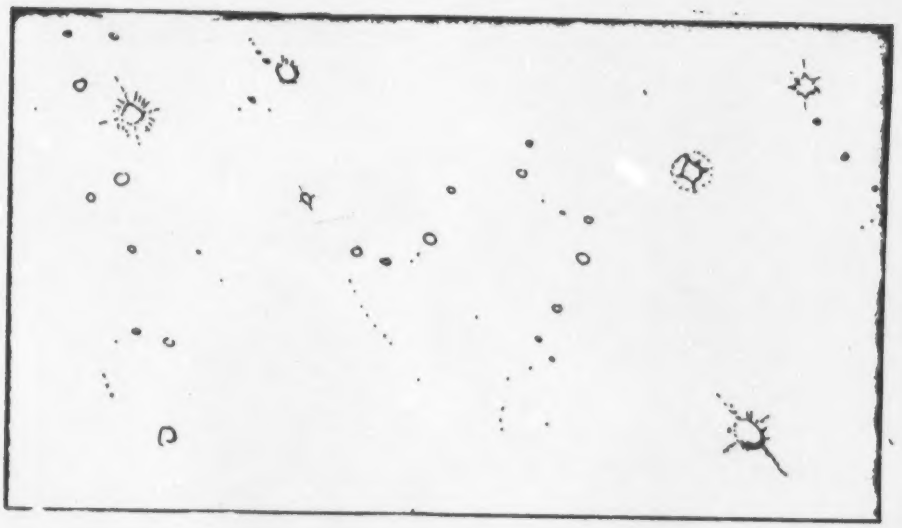
CARD 4





CARD 5

CARD 6



Appendix 2: The key questions covered in the interviews.

Initially children were introduced to the word 'weather' and asked for their meaning of the word. Thus

What does the word "weather" mean to you? What is weather?

1. Clouds: What are clouds made of?
   Where do they come from?
   Where do they go to?
   Have clouds got anything to do with weather?

2. Rain: What is rain?
   Where does it come from?
   Where does it go to?

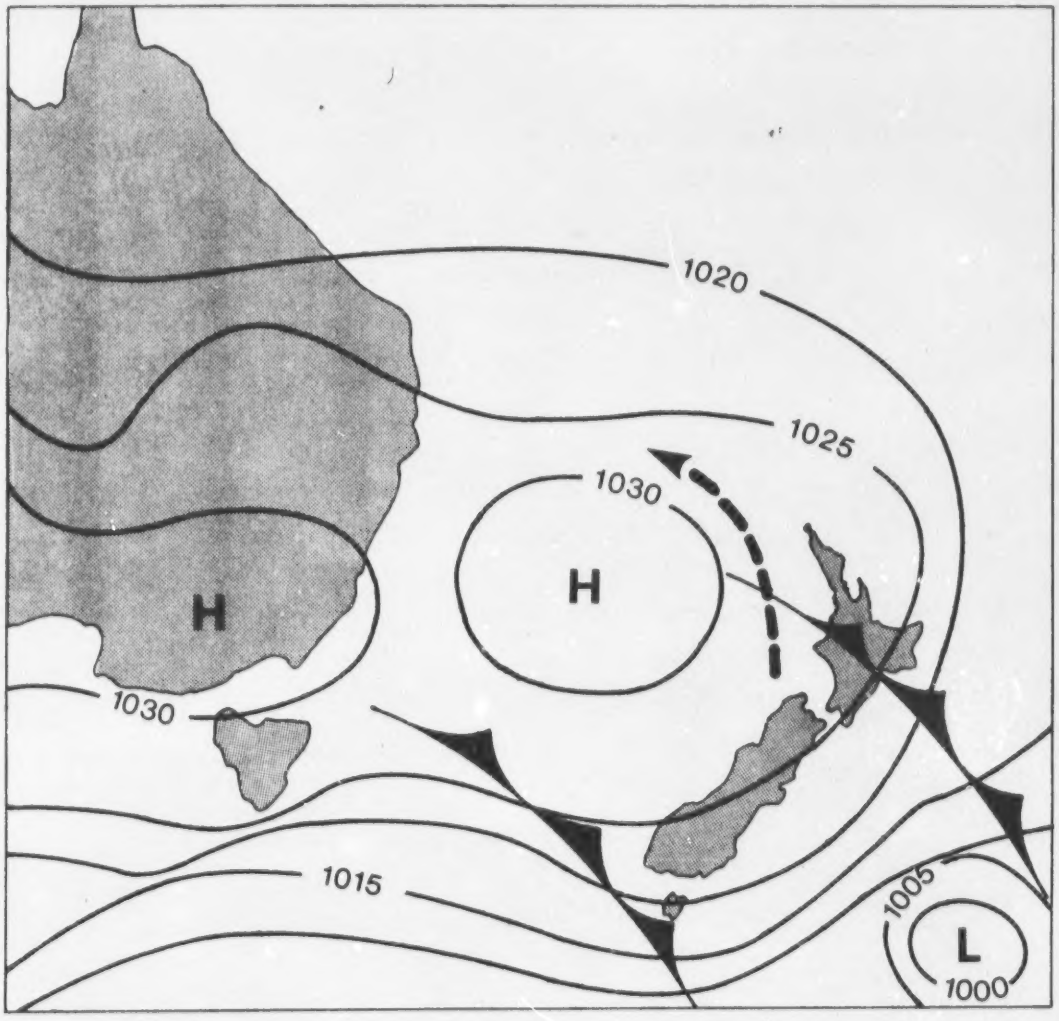
3. Wind: What is wind?
   Where does it come from?
   Where does it go to?
   What makes the difference between a fast wind and a slow wind?
   Has wind got anything to do with weather?

4. Sun: Has the sun got anything to do with weather?

5. Moon: Has the moon got anything to do with weather?

6. Stars: Have the stars got anything to do with weather?

Appendix 3: Weather Map



Copy of map used to gather ideas on understandings of weather maps.

Appendix 4: The relative distances to sun, moon and the stars.

An additional investigation was undertaken to obtain children's views on the relative distances to the clouds, moon, sun and stars. At the end of each 'weather' interview, the child was presented with four cards individually labelled CLOUDS, MOON, STARS, SUN. These cards were placed randomly on the desk in front of the child and the following introduction was given:

> "We are going on a trip and I have a special rocket that can take off just outside the room. My rocket has no difficulty in getting anywhere and I want to go to these four places - indicating the four cards - and I want to take four separate trips to each of these. What would be the first place I would reach?"

In all cases the student chose the clouds, and I then gave them the base that 'if it took 5 minutes to reach the clouds, what would be the next place that I would reach, going at the same speed, and how long would it take? The student then chose a card and gave an indication of the time it would take.

Order of Objects

In Table 4.1 all the sequences that are possible in ordering the distances to the moon, sun and stars is given. The numbers indicate the students who selected each possibility. The correct sequence is shaded.

In considering Table 4.1 it is interesting to note,

(i) 50% approximately of the male students interviewed were able to order the four cards in the correct sequence.

(ii) only 15% of the female students were able to place objects in correct sequence. (407 409 605)

Time of Travel

In Table 4.2 the assessed times to travel to the clouds, moon, sun and stars is provided. It is interesting to compare these estimates with the calculated times assuming the clouds to be 5km above the earth, i.e. a rocket speed of 1km/min. At this speed the three other times would be:

	DISTANCE	TIME at 1km/min
MOON	378,000 km	262 days
SUN	150,000,000 km	285 years
CLOSEST STAR	41,000,000,000,000 km	78 million years

In considering Table 4.2 it is interesting to note;

(i) The younger students kept to a short time span generally, giving the differences in minutes, hours or days.

(ii) Older students increased the time span to terms of months, or years.

(iii) Of all the students interviewed, only one (407) gave a response that had a time sequence that even approximated to the time needed to complete the trips, even though she confused light-years (a measure of distance) with time. i.e. clouds 5 mins
moon 2 hours
sun 5 light years
stars billions of years.
One boy (404) also made reference to light years.

(iv) Three students made reference to the fact that it would be impossible to get to the sun because of the heat factor,

"You couldn't get there, the heat would burn you up."
(04, 202, 606)

One student also stated that apart from the heat the time factor would make it impossible,

"You would be dead because of the time." (202)

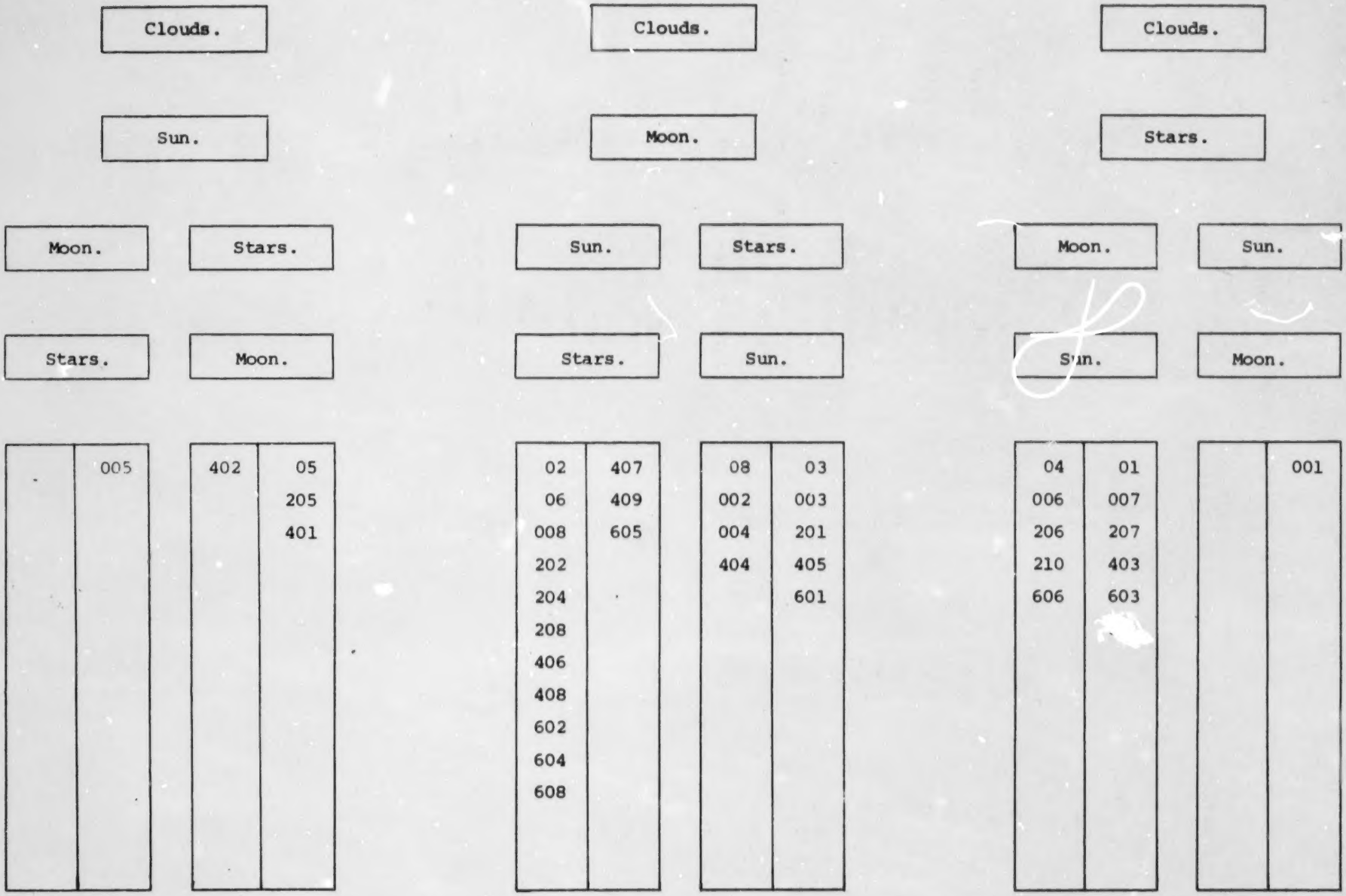


Table 4.1 Relative Proximity of Clouds, Moon, Sun and Stars

Table 4.2: Time of Travel to Clouds, Moon, Sun and Stars

	Clouds	Sun	Moon	Stars
005	5 min	3 hrs	4 hrs	24 hrs

	Clouds	Sun	Stars	Moon
402	5 min	10 min	15 min	20 min
05	5 min	10/20 min	30 min	50 min
401	5 min	20 min	25 min	1 hr
205	5 min	1 day	2 days	6 days

	Clouds	Moon	Sun	Stars
02	5 min	15 min	30 min	50 min
008	5 min	15 min	1 hr	many days
602	5 min	3 hrs	12 hrs	14 hrs
604	5 min	25 min	1 day	ages/weeks
06	5 min	2 days	3 days	12 days
608	5 min	1 hr	10 hrs	1 week
204	5 min	2 days	2 weeks	1 year
208	5 min	2 days	weeks/months	years
605	5 min	2 weeks	3 years	10 years
406	5 min	1 day	10/20 years	40 years
202	5 min	12 hrs	you would never get there - heat and time	
408	5 min	4/5 days	never get there ...	
407	5 min	2 hrs	5 light yrs	billions yrs
409	no times recorded			

	Clouds	Moon	Stars	Sun
003	5 min	10 min	15 min	30 min
601	5 min	15 min	20 min	60 min
201	5 min	20 min	45 min	90 min
405	5 min	2 days	2 days +	3 days
03	5 min	5 hrs	6 days	5 weeks
08	5 min	3/4 days	5/6 days	12 days
004	5 min	18 hrs	3.5 days	few months
002	5 min	few months	more than moon	1 year
404	5 min	2 days	just after moon	light years

	Clouds	Stars	Moon	Sun
01	5 min	10 min	16 min	20 min
207	5 min	10 min	15 min	20 min
607	5 min	15 min	20 min	30 min
007	5 min	20 min	30 min	60 min
606	5 min	10 min	a few more mins	never get there - too hot
04	5 min	20 min	2 mths & 3 days	wouldn't get there
206	5 min	24 hrs	1 week	2 months
210	5 min	30 min	2 days	4 months
403	5 min	5/6 hrs	6 weeks	years
603	5 min	1 day	months	wouldn't get there

	Clouds	Stars	Sun	Moon
001	2 min	5 min	10 min	1 hr

Appendix 5: Some very elementary scientific ideas about weather.

Weather: Weather is very much an everday term to describe the atmospheric conditions which are observable by humans. We observe or sense the temperature, whether it is sunny or cloudy, wet or fine, windy or calm. These features of the atmospheric conditions tend to be the key features in thinking about weather.

Clouds: Large quantities of water are present in the atmosphere. This water is often in the form of invisible minute particles individually suspended in the air. In this form the water is not observable by the human eye. However, if these minute water particles join together water droplets form in the air and large collections of these become visible as clouds. Clouds at ground level are called mist or fog.

Rain: Water droplets, within the clouds, are initially small enough to remain suspended in the atmosphere. As they grow larger, by combining with other water particles they become heavier and fall toward the earth.

Sun: This is responsible for heating the earth's surface. As the lower air is heated, it expands, becomes less dense and rises. The resulting circulation of the air (convection currents) distributes the heat throughout the atmosphere. The earth's surface starts to cool after the sun has set, the earth acting at all times like a large low temperature radiator with respect to outer space. Atmospheric cooling also takes place simply by being in contact with the earth's surface as the surface cools down.

Wind: This is the horizontal movement of air close to the earth's surface, set up by convection currents. The heating effect of the sun is the prime cause of this movement of air. The earth's rotation deflects the wind as it moves from high to low pressure areas, causing huge whirlpool effects.

Moon: Although the moon does influence the tides, the moon, planets and stars (other than our sun) have no real influence on the earth's weather systems.